MORTALITY AMONG EMPLOYEES OF A SARNIA ONTARIO FACTORY WHICH MANUFACTURED INSULATION MATERIALS FROM AMOSITE ASBESTOS: A REPORT AND PROPOSAL FOR FURTHER STUDY

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INDEX

Executive Summary . . . . . Page 3
Introduction. . . . . Page 5
Description of Factory Processes. . . . . Page 8
Study Methods . . . . . .Page 10
Results . . . . . .Page 12
Discussion. . . . . .Page 15
Conclusions . . . . . .Page 17
References. . . . . .Page 18
Appendix. . . . . .Page 19

EXECUTIVE SUMMARY

Amosite is an amphibole asbestos mineral mined in South Africa. Its high resistance to heat makes it suitable for use as an insulating material, and in this role it has been incorporated into manufactured materials and sprayed as insulation on construction projects. International experience has shown that factory workers who manufactured insulation materials using amosite asbestos are at high risk of asbestos-associated disease.

Insulation materials were manufactured at Holmes Insulations Limited in Sarnia, Ontario using amosite asbestos from 1956-1974. Using, primarily, a list compiled by the Occupational Chest Disease Service of the Ministry of Labour, a roll of 152 former employees was assembled and the mortality experience of the workers was traced. Among the 108 men who could be identified as having worked in asbestos exposure, there was a 6-fold increase in lung cancer mortality (4 deaths observed; 0.66 expected), a 7-fold increase in respiratory disease mortality (3 deaths observed; 0.42 expected), and there were 2 deaths from mesothelioma. A third death from mesothelioma has occurred since the close of follow-up for this study, and 2 additional deaths from mesothelioma are known to have occurred among former Holmes workers not on our roll. Three of the 5 men dying of mesothelioma were less than 50 years of age at death and all were less than 60 years.

The 152 former workers we could identify and place on the study roll are only a subset of employees who worked with asbestos at the factory. As a result of the present analysis of the health experience of Holmes Insulation workers, the following actions are proposed:

1) With the approval of the Registrar General, who is the custodian of the Death Registry data, a list of names of all Holmes workers who died of asbestos-associated diseases will be provided to the Workers' Compensation Board.

2) An effort should be made to locate all surviving ex-employees. All workers should be advised to quit smoking because smoking increases the risk of lung cancer following

asbestos exposure. All workers should be offered an examination for the detection of asbestosis. No other medical interventions are currently of value for the prevention or detection of asbestos disease.

3) All surviving workers should be maintained under indefinite surveillance.

4) Efforts should be made to identify all workers who worked in asbestos exposure at Caposite/Holmes Insulations. This could be done as follows:

a) Ask workers currently on the roll for the names of co-workers.

b) Advertise in the Sarnia media for individuals who worked at the plant.

c) Solicit the assistance of the Canadian Auto Workers to identify former workers.

d) Examine the employee records of Holmes (now Partek) Insulations to identify workers employed in 1974 or earlier.

e) Examine the employee records of Holmes Foundry Limited to identify workers who may have worked for the Insulation Division of Holmes Foundry Limited. This task is likely to involve a large clerical effort. Since foundry workers are also known to face an increased risk of lung cancer (see the Appendix) it might be reasonable to collect information for a mortality study of Holmes Foundry workers at the same time as the records are being examined to find asbestos-exposed employees.

INTRODUCTION

Amosite is an amphibole asbestos mineral mined in South Africa. Its high resistance to heat makes it suitable for use as an insulating material, and in this role it has been incorporated into manufactured materials and sprayed as insulation on construction projects. Regrettably, amosite asbestos forms a toxic dust and some of the factory workers and insulation sprayers have suffered disability and death as a result of their workplace exposures.

Professor I. Selikoff and his team at The Mount Sinai School of Medicine in New York published the first reports on the effects of exposure to amosite asbestos on the health of workers. Studies of the health of some 18000 members of the Asbestos Insulators Union[1] revealed high rates of cancer and lung disease among these workers who used both chrysotile and amosite asbestos in their jobs.

These researchers have also recently published an updated study of mortality among workers who used solely the amosite variety of asbestos at an insulation materials factory in Patterson, New Jersey[2]. A cohort of 820 men who began work in the factory during 1941-1945 was observed from 5 to 40 years after start of work. Most of the cohort had limited duration of work experience (days, weeks, months) though some men worked for several years until the factory closed in 1954. With New Jersey men as the reference population, a 5-fold increase in mortality risk was evident for lung cancer and pulmonary diseases (including asbestosis), while the increase in risk was almost 3-fold for total cancer and was about 1.7 for all causes of death. In addition, there were 17 deaths from mesothelioma in the cohort.

In his book "Expendable Americans"[3], Paul Brodeur has presented the history of an asbestos insulation factory in Tyler, Texas (a sister factory to the plant in New Jersey) and discussed the adverse effects of exposure to amosite asbestos on the health of the employees. This plant was closed in 1972 following the measurement of extremely high asbestos dust levels by governmental hygienists. Brodeur reports that,

following closure of the plant, 10000 bags of amosite asbestos left over in the plant warehouse were shipped to Holmes Insulation in Point Edward, Ontario[4].

In 1956 Caposite Insulations Limited (which was later known as Holmes Insulation Limited, the Insulation Division of Holmes Foundry Limited) began manufacturing insulation products using amosite asbestos imported from South Africa. Caposite was a pipe insulation made up of amosite asbestos (55-60%), perlite, dicalite, and silicate. During the 1960s, the manufacture of "Uniblock" insulation was begun in the same factory building. Uniblock was a compressed rock wool insulation formed from a mixture of rockwool, asbestos, perlite, and resins. Rockwool insulation materials had been manufactured throughout this period in a separate building on site. Manufacture of asbestos-containing materials was terminated on March 22, 1974. The Company re-located to a new site in Sarnia and was purchased by Babcock-Wilcox.

Some of the former employees of Holmes Insulation Limited are under medical surveillance by the Occupational Chest Disease Service (OCDS) of the Ministry of Labour. When the Company relocated in 1974, some 20-25 employees who had worked in asbestos exposure moved with them. These workers continued in the surveillance program and, in 1983, 18 of them were still being followed.

According to hygiene inspection reports, environmental conditions in the asbestos plant were poor. In many locations dust counts greatly exceeded the TLV in effect at the time. The asbestos workers of Holmes Insulation are at high risk of asbestos-related disease because of the toxicity of amosite asbestos and the poor environmental conditions under which they worked. Indeed, a number of these men have received Workers' Compensation awards for asbestosis and cancer. The author thus undertook to trace the health experience of these workers in order to establish the extent of the risk that they face and to identify individuals qualifying for Compensation awards for asbestos-induced illness.

The findings to be presented in this report indicate that these Ontario workers have not been spared the disease

experienced by their brethren in other jurisdictions. Proposals are made for the further identification of workers at risk, for notifying these workers of the hazard, and for the future monitoring of their health experience.

DESCRIPTION OF THE FACTORY PROCESSES

There were 2 main operations involving the use of amosite asbestos: the manufacture of Caposite, and Uniblock insulations. Long and fine fibred asbestos, imported from South Africa was used to make pipe covering insulation (Caposite) with the following ingredients:

Amosite asbestos	55-60%
Perlite (a low silica expanded volcanic ash)	7%
Dicalite (a type of diatomaceous earth)	12%
Silicate	21-24%.

Total production was about 10,000 lb per day with 5% scrap recycled to the process. Asbestos was received in 100 lb jute bags which were torn open and the contents dumped on a feed platform, creating a huge pile of asbestos. The pile was broken by means of a pitchfork and fed into one of 3 crude feeder chutes housing slow moving conveyors. The feed then went down to 3 disintegrators, at which point some ground scrap was also added. The recycling of the scrap material was done by chopping the waste in a hopper and then blowing it into a storage room. The operator entered the room to remove the scrap by shovel.

The mix from the disintegrators was blown to three cyclones which then dropped the mix to the feed cabins. From the cabins, the mix went to a mat conveyor which was sprayed with a sodium silicate solution. The wet mat was then rolled onto mandrels and compressed. Later, the mandrels were removed and the pipes were cured in ovens before being sent to the trimming and splitting machines.

Uniblock insulation was essentially a compressed rock wool insulation formed into blocks. Rock wool was mixed with asbestos, perlite, and resins in a double rotor agitator. The mix was then automatically metered from the mixer, compressed, shaped, and stacked for curing.

These 2 operations were carried out in a building about 75 feet square by 15 feet high. There was no general exhaust in the building, but local exhaust was applied at the various

operations. The environment was dusty. The following dust counts were obtained in 1958 by a Department of Health hygienist who used the Greenburg-Smith impinger to measure total dust. The results are expressed as millions of particles per cubic foot (MPPCF); given the percentage of asbestos in the mix a rough conversion to fibres/ml might be made by multiplying the result in MPPCF by 4 or 5.

Dust Counts (Greenburg-Smith Impinger)

On platform. Disintegrating machine #1 going	15.3 MPPCF
Beside pipe rolling machine #3	2.1 MPPCF
Behind pipe rolling machine #3	134.4 MPPCF
Feed end of automatic saw	4.4 MPPCF
Discharge end automatic saw	4.2 MPPCF

The first fibre counts were made by Department of Health hygienists in January, 1973 when the exposure guideline was 2 f/cc. The results were as follows:

"Caposite" Line:	
Inside disintegrator enclosure	852 f/cc
Disintegrator feed hopper, beside operator	640 f/cc
Between rolling machines 2 and 3 (feed end)	243 f/cc
Between rolling machines 1 and 2 (rolling end)	1.8 f/cc
Automatic trim saw, feed end	7.9 f/cc
Automatic trim saw, discharge end and packing	35.3 f/cc
Large "band" saw	5.4 f/cc
Background, in aisle beside office	1.0 f/cc
"Uniblock" Line:	
Discharge end	2.1 f/cc
Mixing platform	10.1 f/cc

STUDY METHODS

A) Identification of Employees

The optimal method of identifying a cohort of industrial workers is by the collection of a roll of names and work histories from company files. This could not be done in this study because of the complication created by the change of company ownership. In November of 1982 a list of 127 former employees of Holmes Insulations was obtained from Mr. Jake Penner of the Occupational Chest Disease Service(OCDS) of the Ministry of Labour. This list had been compiled in 1975 from the file of examination cards maintained by the OCDS. These cards had not been designed to record information for epidemiologic purposes and some of the information obtained from them was of poor quality for tracing the workers. Eighty-nine of the 127 individuals had only a birth year, rather than a full date of birth, recorded. Eight workers had only family name and initials, rather than full name recorded. This imprecise information made it possible that ascertainment of the deaths of some individuals would be missed during tracing.

The Manager of Industrial Relations at Holmes Insulations informed us, in January 1983, that in 1970 the insulation group was separated from Holmes Foundry Ltd and new premises were built. All employee records prior to 1970, including those in Caposite and Insulations, were part of the original company and left at their facility. Any employee who was still employed by Holmes transferred to the new asbestos-free establishment. He indicated that he had the records of 15 individuals from the OCDS list.

The Manager of Industrial Relations at Holmes Foundry indicated that records were sketchy prior to 1968. He sent a list of the names of 20 individuals who had worked in the asbestos operations; 8 of these were not on the OCDS list and were added to it to create a roll of 131 individuals.

The workers at Holmes Insulations were represented by the United Auto Workers. Union officials did not respond to requests for information.

In April 1987, the author examined all the Holmes

Insulation examination cards at the OCDS. Twenty-one additional eligible workers were identified and added to the roll. The final roll consists of 152 men; 131 from the OCDS and Company lists and 21 added by the author's search of the OCDS files. Sufficient information was available on period of employment and location to include 134 of the 152 men in the analysis of mortality.

B) Tracing of Workers

The original roll of 131 individuals was submitted to Statistics Canada for a mortality search. Acceptable matches to the Mortality Data Base were found for 17 men. Residence or death in Sarnia was a powerful identifier because of the suboptimal quality of much of the identifying information. It is possible that men who had moved from Sarnia and died elsewhere were missed in the trace. A manual search of the Ontario Death Register was made for the 21 individuals added to the roll in April 1987 and 2 deaths were found among this group.

C) Statistical Analysis

A standard person-years analysis was used to compare mortality in the Holmes cohort with mortality rates in the general male population of Ontario. Person-years at risk in 5-year age and calendar period cells were calculated using the Person-Years computer program written by Professor J. Peto[5]. One-sided P-values were calculated assuming a Poisson distribution of observed deaths.

RESULTS

This section presents the results of the mortality analysis. Workers were divided among 3 groups in order to test for the presence of an asbestos dose-response relationship. The classification was done using information recorded on the OCDS examination cards, and is not precise with respect to actual exposure to asbestos. Group 1 consists of the 53 men who worked in asbestos exposure for less than 2 years. Group 2 is comprised of the 55 men who worked in asbestos exposure for 2 years or more. Men whose job title indicated employment in the rockwool plant were placed into Group 3, which is here treated as a group with minimal or background exposure to asbestos. Since the job title on the Clinic Card may not reflect the various jobs held during employment, some of the 26 men in this group may well have had substantial exposure to asbestos. An additional 18 men could not be classified because there was no job title available or because there was no indication when these men were employed.

Table 1 presents the mortality results for those in asbestos exposure less than 2 years. Three deaths were identified among the 53 men in this group, which was the same number as predicted from Ontario rates. Of these 3 deaths, 2 were due to trauma (not work-related) and one was from lung cancer.

TABLE 1: Mortality Among Workers Exposed to Asbestos for Less Than 2 Years

CAUSE of DEATH	OBSERVED	EXPECTED
All Causes	3	2.95
All Malignancies	1	0.61
Lung Cancer	1	0.19
Mesothelioma	0	0
Respiratory Disease	0	0.15
Circulatory Disease	0	1.11
Accidents	2	0.74

Table 2 displays the mortality observed among the 54 men who worked in asbestos exposure for 2 years or more. Six of the 10 deaths were due to cancer (1.4 deaths were expected to be due to malignant disease); these included 3 deaths of lung cancer, 2 of mesothelioma, and a carcinoma of the kidney. In addition 3 deaths were due to respiratory disease, where 0.27 would have been expected. Two of these 3 deaths were attributed to asbestosis and one of them to pneumonia.

Table 2: Mortality Among Workers Exposed to Asbestos for 2 Years or More

CAUSE of DEATH	OBSERVED	EXPECTED	SMR	P-VALUE
All Causes	10	6.23	161	P=0.10
All Malignancies	6	1.43	420	P<0.01
Lung Cancer	3	0.47	641	P=0.01
Mesothelioma	2	-	-	
Respiratory Disease	3	0.27	1100	P<0.01
Circulatory Disease	1	2.66	38	

The men who died of mesothelioma were 47 and 49 years of age at death; the intervals from first exposure were 26 and 21 years respectively. After the end of the follow-up period for this study, a third man in this group of 55 died of peritoneal mesothelioma in May, 1986. He was 50 years old when he died, 27 years after first employment. In addition to these 3 men, 2 other Holmes employees have received Compensation awards for mesothelioma. The names of these men do not appear on any list available to us when the cohort was assembled. Both of these men began work in the mid-1950s. One died in April 1987, at the age of 59, of pleural mesothelioma. The other man died in 1982, at the age of 42, of peritoneal mesothelioma.

The men who died of lung cancer were 49, 64, and 69 years of age; the intervals from first employment were 14, 22, and 26 years respectively.

The man who died of lung cancer at age 49 had worked for

14 years as a pipe roller and sawyer. Professor A. C. Ritchie, the Consultant in Pathology to the Workers Compensation Board reviewed the slides from the autopsy. He found numerous asbestos bodies in the lung tissue and commented "I have never seen a case in which contamination by asbestos is so great." With respect to a 54 year old man who died of asbestosis Dr. Ritchie reported finding severe asbestosis. This man had worked for 8 years as a pipe roller.

Two of the 10 deaths were from causes not usually attributed to asbestos exposure, namely kidney cancer and heart attack. For the man who died of a heart attack, Dr. Ritchie reported severe asbestosis.

The findings with respect to mortality among the 26 men who were classified as unexposed are presented in Table 3. There was one death from malignant disease, a brain tumour, which occurred 10 years after the start of employment in the Rockwool plant.

Table 3: Mortality Among the Unexposed Workers

CAUSE of DEATH	OBSERVED	EXPECTED
All Causes	5	3.3
All Malignancies	1	0.70
Lung Cancer	0	0.21
Mesothelioma	0	0
Respiratory Disease	1	0.18
Circulatory Disease	2	1.51
Accidents	1	0.51

One death occurred among the 19 men who could not be classified. This was a death due to a heart attack.

DISCUSSION

International experience has shown that factory workers who manufactured insulation materials using amosite asbestos are at high risk of asbestos-associated disease. A doubling of the risk of lung cancer occurred among 4820 men engaged in the manufacture of insulation board at an English factory (6). In addition there were 5 deaths from mesothelioma and 9 from asbestosis. There was no trend of increasing lung cancer mortality with increasing duration of employment at the factory, nor was there the suggestion of a trend of increasing lung cancer mortality with increasing time since first exposure. In the New Jersey factory, there was a 5-fold increase in the risk of death from lung cancer and pulmonary diseases(2).

The workers at Holmes Insulation Ltd in Sarnia, Ontario must now be added to this international list. Among the 108 men who could be identified as having worked in asbestos exposure, there was a 6-fold increase in lung cancer mortality (4 deaths observed; 0.66 expected), a 7-fold increase in respiratory disease mortality (3 deaths observed; 0.42 expected), and there were 2 deaths from mesothelioma. (A total of 5 deaths from mesothelioma has been identified among Holmes workers. Three of the 5 men dying of mesothelioma were less than 50 years of age at death and all were less than 60 years.) A number of additional deaths may have been missed because of the poor quality of much of the personal identifying information and these risk estimates may thus be low.

It was possible to compile a list of 152 workers, but it is certain that this list is incomplete. As evidence of this, two former Holmes employees have received Compensation for mesothelioma. Their names do not appear on any of the lists used to compile the roll for this study. Brodeur (page 192) quotes a Department of Health official as indicating that the workforce was between 50 and 75 men. Asbestos was used from 1956 to 1974 and it is unlikely that the total size of the workforce exposed over this period was only 152 men. Because of the risk these workers have incurred it is important to make an

extensive effort to identify as complete a list as possible of exposed employees.

As a result of the present analysis of the health experience of Holmes Insulation workers, the following actions are proposed:

1) With the approval of the Registrar General, a list of names of Holmes workers who died of asbestos-associated diseases will be provided to the Workers' Compensation Board.

2) An effort should be made to locate all surviving workers on the roll. All workers should be advised to quit smoking because smoking increases the risk of lung cancer following asbestos exposure. All workers should be offered an examination for the detection of asbestosis. No other medical interventions are currently of value for the prevention or detection of asbestos disease.

3) All Holmes workers should be maintained under indefinite surveillance.

4) Efforts should be made to identify all workers who worked in asbestos exposure at Caposite/Holmes Insulations. This could be done as follows:

a) Ask workers currently on the roll for the names of co-workers.

b) Advertise in the Sarnia media for individuals who worked at the plant.

c) Solicit the assistance of the Canadian Auto Workers to identify former workers.

d) Examine the employee records of Holmes (now Partek) Insulations to identify workers employed in 1974 or earlier.

e) Examine the employee records of Holmes Foundry Limited to identify workers who may have worked for the Insulation Division of Holmes Foundry Limited. This task is likely to involve a large clerical effort. Since foundry workers are also known to face an increased risk of lung cancer (see the Appendix) it might be worthwhile to collect information for a mortality study of Holmes Foundry workers at the same time as the records are being examined to find asbestos-exposed employees. This study would aim to establish if the lung cancer excess found elsewhere has also occurred in the Holmes Foundry.

CONCLUSIONS

Amosite asbestos is no longer used for manufacturing purposes in Ontario. Former employees of Holmes Insulations Limited in Sarnia are at high risk of asbestos-associated disease as a result of exposures during 1956-1974. These workers should be monitored for the development of asbestos disease. A series of proposals to accomplish this is presented.

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APPENDIX: LUNG CANCER IN FOUNDRY WORKERS

A number of epidemiological studies in the past decade have shown foundry workers to be at increased risk of lung cancer. Koskela and colleagues(A1) studied the mortality experience of 3800 workers from the foundry sector in Finland. Twenty-one workers died of lung cancer compared with an expectation of 14. Lung cancer mortality was higher in iron foundries than in foundries of other types. This study was followed by a Finnish case-control study(A2) of 3425 iron foundry workers in an effort to determine causative factors in the foundry environment. Attention was focused on the polycyclic aromatic hydrocarbons(PAH), but measurements performed in foundries did not reveal great differences among the exposures of different occupational groups; all groups had some exposure to PAHs. An association was found between the estimated extent of exposure to PAHs and the risk of lung cancer, but this association was not statistically significant.

Gibson and colleagues(A3) studied lung cancer mortality at DOFASCO, a steel foundry in Hamilton. The study group consisted of all employees and retirees who were 45 years of age or older - 1542 individuals. A hygiene survey was undertaken in conjunction with this analysis, specifically to measure levels of particulates, the benzene soluble fraction of total suspended particulates, and metals. All employees were assigned to a "foundry" or "non-foundry" group depending upon whether or not they had spent more than 5 years in the foundry. The relative risk, comparing foundry to non-foundry workers, was elevated 5-fold for lung cancer, but was not significantly increased for total cancer mortality or for deaths from all causes combined. In this factory, crane operators had the greatest increase in risk. In order to identify causative factors, additional environmental testing was performed(A4). Initial analysis was not particularly helpful. Four known PAH carcinogens were identified; the concentrations were quite low and did not indicate any gradation between foundry areas. Inorganic

material was measured in trace amounts or at levels well within accepted guidelines.

Decoufle and Wood[A5] studied mortality among workers at a gray iron foundry that was an integral part of a large industrial plant in a northern U.S. city. The study group was derived from the male work force of the entire plant who had accumulated at least one year employment in "blue collar" jobs prior to 1968. Among 24,000 men meeting these criteria, 2861 had worked in the foundry for at least one month and were included in the study cohort. The number of men who had spent any substantial time in the foundry and who had a sufficiently long follow-up interval was small and a small excess of lung cancer was observed among them.

Egan-Baum and colleagues[A6] performed a proportional mortality study of deaths occurring among members of the International Molders and Allied Workers Union using records maintained by the Union. Death certificates of 2990 foundry workers were analyzed. Increased proportional mortality due to lung cancer and non-malignant respiratory disease was observed.

To follow-up the observation of lung cancer excess among DOFASCO workers, Fletcher and Ades[A7] carried out a large cohort study for the Steel Castings Research and Trade Association in England. The cohort was comprised of 10,250 workers who were employed for at least one year in one of 9 English steel foundries. There was significantly increased lung cancer mortality among men with foundry and fettling shop occupations. As with the other studies described above, smoking data was not available.

Silverstein and colleagues[A8] performed a proportional mortality analysis of deaths occurring among 278 male hourly workers who were employed for at least 10 years at an American gray iron foundry. There was a significant excess proportional mortality due to lung cancer.

ASSESSMENT: Studies of iron and steel foundry workers consistently show an excess risk of lung cancer. The causative agent(s) have not yet been identified, but

interest has been focussed primarily on the thermal breakdown products of organic binders or contaminants. None of these studies have had good smoking data for the workers, and smoking may well be contributing to part of this excess. The Ontario Workers Compensation Board recognizes lung cancer occurring in a foundry worker as a compensable disease.

A mortality study of Holmes Foundry workers would aim to determine whether the increased risk observed elsewhere has also occurred in the Holmes environment.

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